Improving Rocket & Flight Vehicle Testing Under Capital Constraints

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Overview & Objectives

Key challenges in rocket and flight vehicle testing.

The importance of leveraging **HIL simulation** and **modular systems** for efficient and budget-conscious validation testing.

Explore **budget-friendly strategies** for testing key rocket & flight vehicle systems.

Showcase **solutions for overcoming testing complexities** in systems for ground support, propulsion, avionics, payload systems, and bus infrastructure.

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Why Efficient Testing is Crucial in Space

Critical nature of flight vehicle testing

The need for resource optimization

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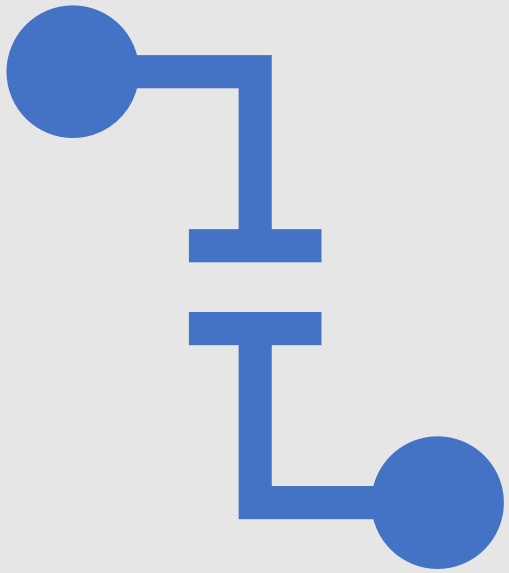
Why Efficient Testing is Crucial in Space

If testing misses a “minor” fault



- **Schedule** disruptions
- **Safety** risks
- **Spontaneous** unscheduled disassembly

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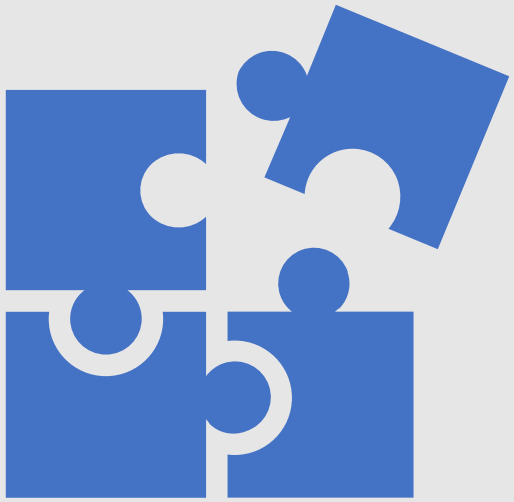
Why Efficient Testing is Crucial in Space

Complexity Demands a Strategic Approach



Hardware-in-the-Loop Simulation

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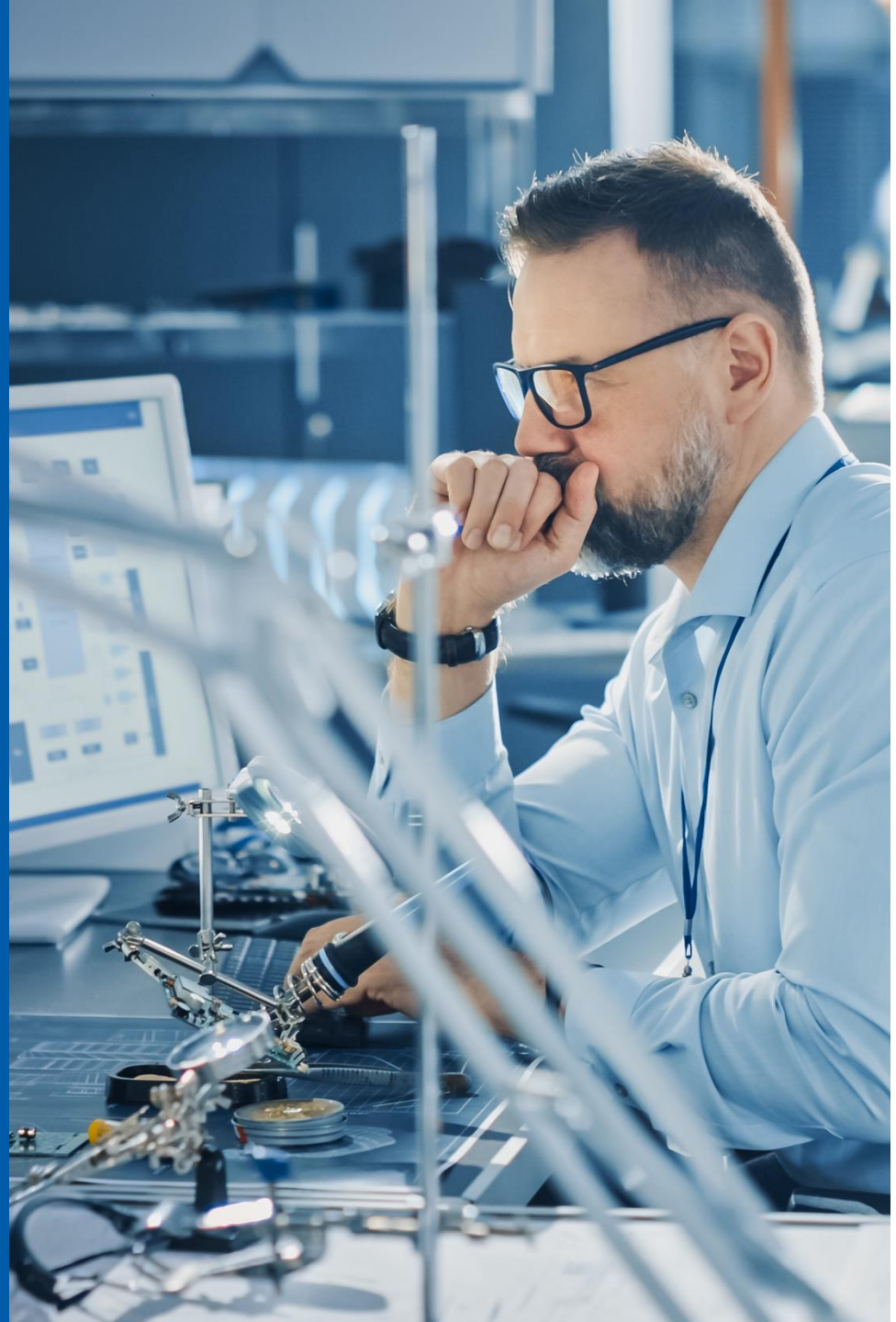

Why HIL Simulation?

- **Time is Short**: Execute a wide variety of tests quickly using simulation and models instead of setting up prototypes and physical test rigs.
- **DUTS are More Complex:** Find and fix bugs earlier in the design process to avoid defects getting out of production.
- **Budgets are Tight:** Testing on physical models is expensive and errors found early in the design process are significantly cheaper to correct.
- **Repeatability**: Test procedures can be 100% replicated to verify future control system upgrades do not impact performance.
- **Safety**: Can replicate extremes of operation without risk of damage to equipment or operators.

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What is HIL Simulation?

- I/O from an embedded control system is connected to a tester that simulates real-world conditions
- The test system provides simulated stimulus to the embedded system
- Validating the integrity and functionality of embedded system designs (and modifications)
- Injection of fault conditions to confirm system response is as expected

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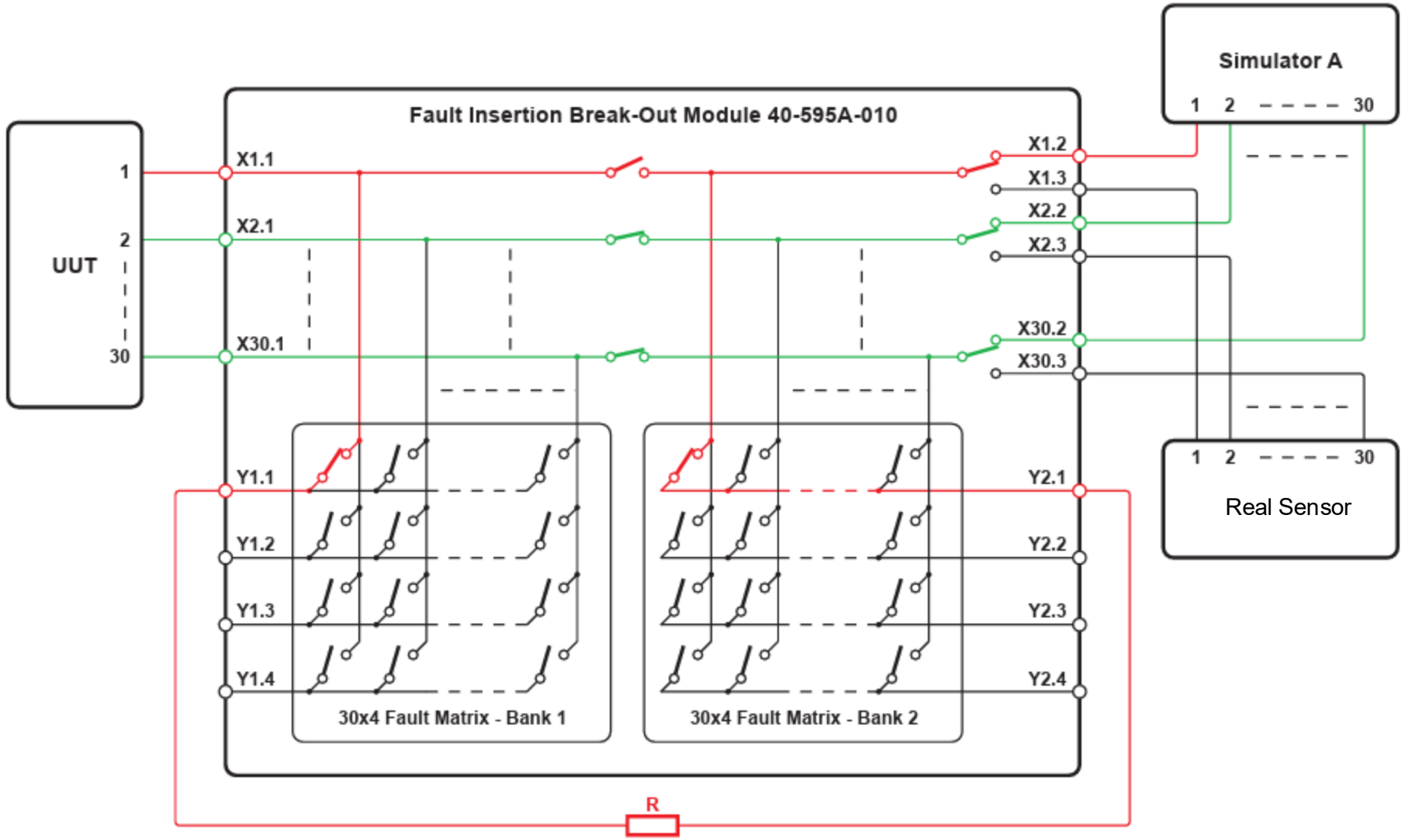
Examples of Fault Matrices



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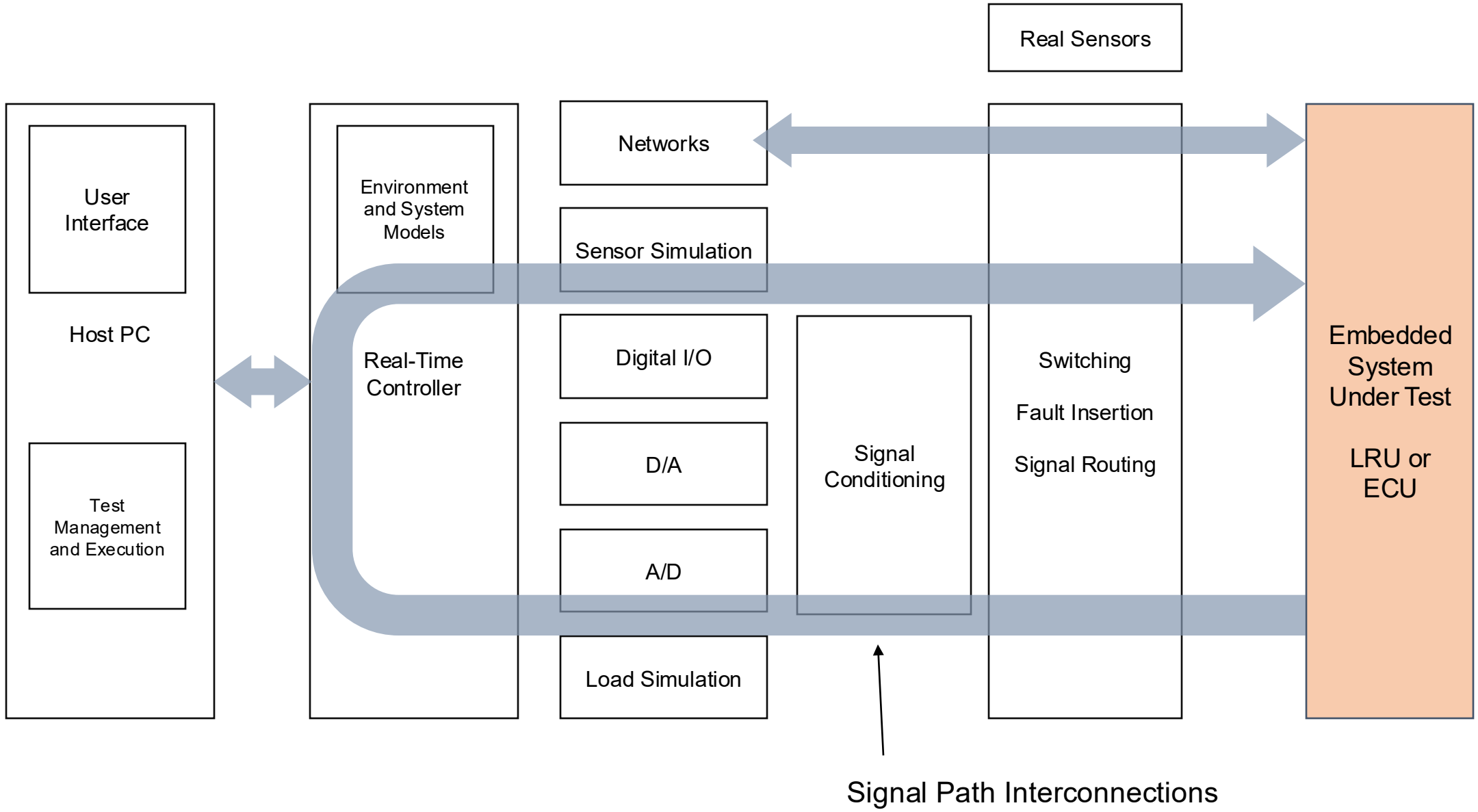
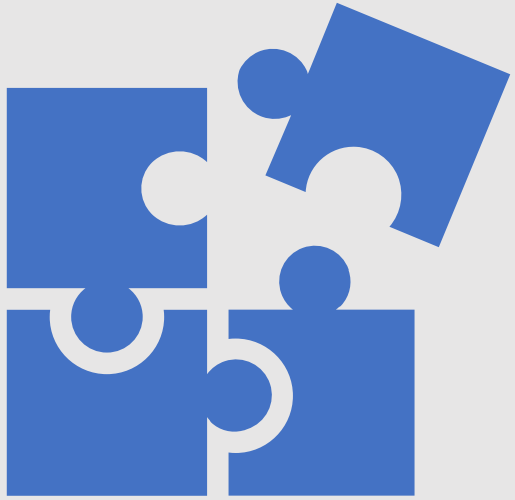
Breakdown of a HIL system



HIL Simulation & Modular Systems



Iterative Test Development & Standardized Interfaces

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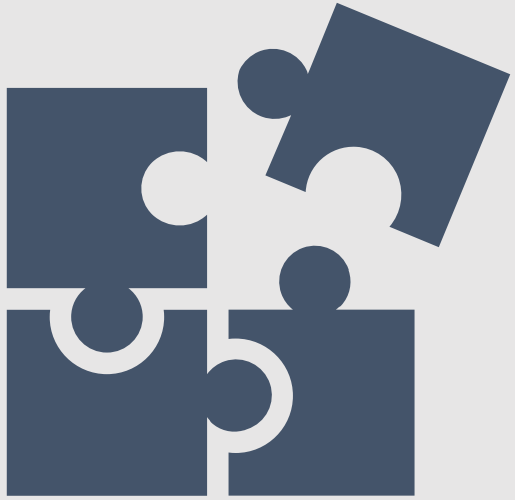
HIL Simulation & Modular Systems



Iterative Test Development

Modular systems allow engineers to adapt test setups as designs evolve, ensuring scalability and flexibility over longer timelines.

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HIL Simulation & Modular Systems

Standardized Interfaces

By aligning test equipment with common requirements, teams can seamlessly switch between different devices under test (DUT).

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HIL Simulation & Modular Systems

Step 1: Evaluate Your UUT Requirements

Sensor Inputs

Communication Interfaces

Power Systems

Frequencies

Fault Conditions

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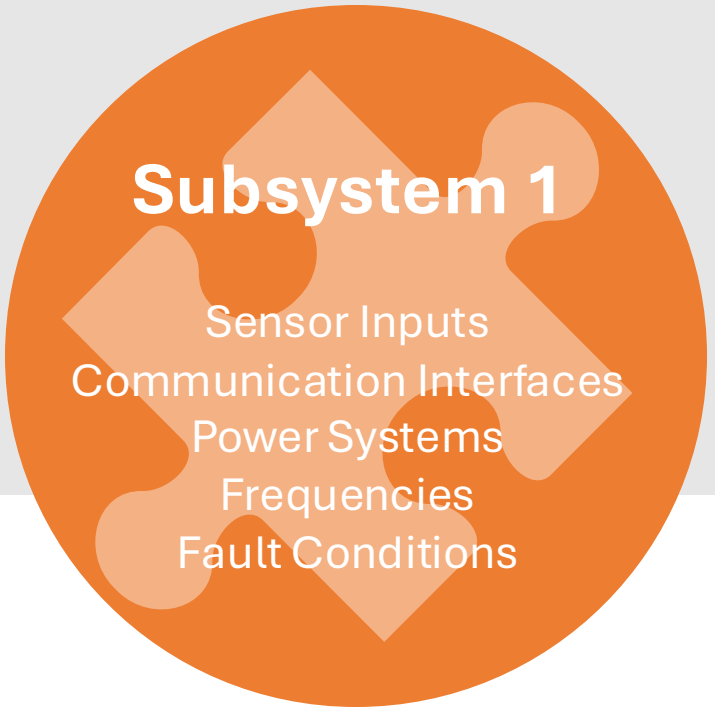
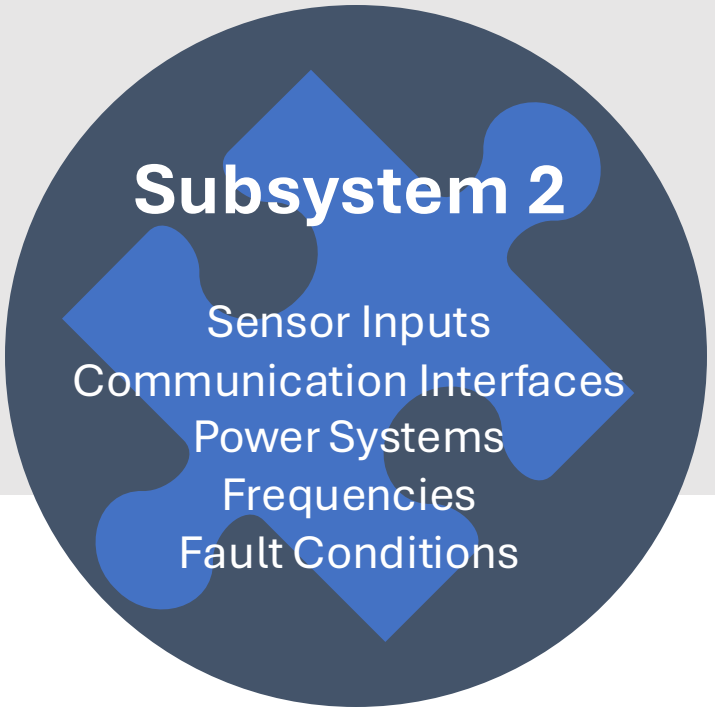
HIL Simulation & Modular Systems

Step 2: Evaluate Your UUT Requirements





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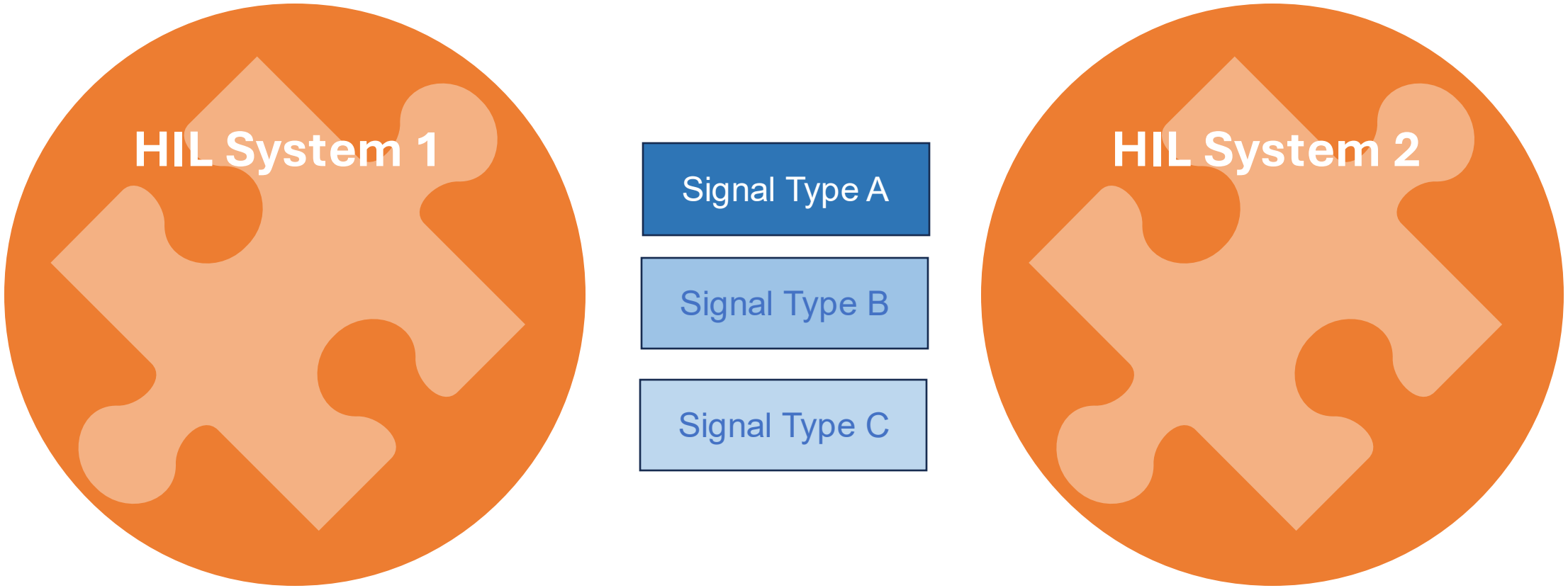
Subsystem Diagram: Generate Signal Types

Requirement Comparison: Generate the designs for the individual modules



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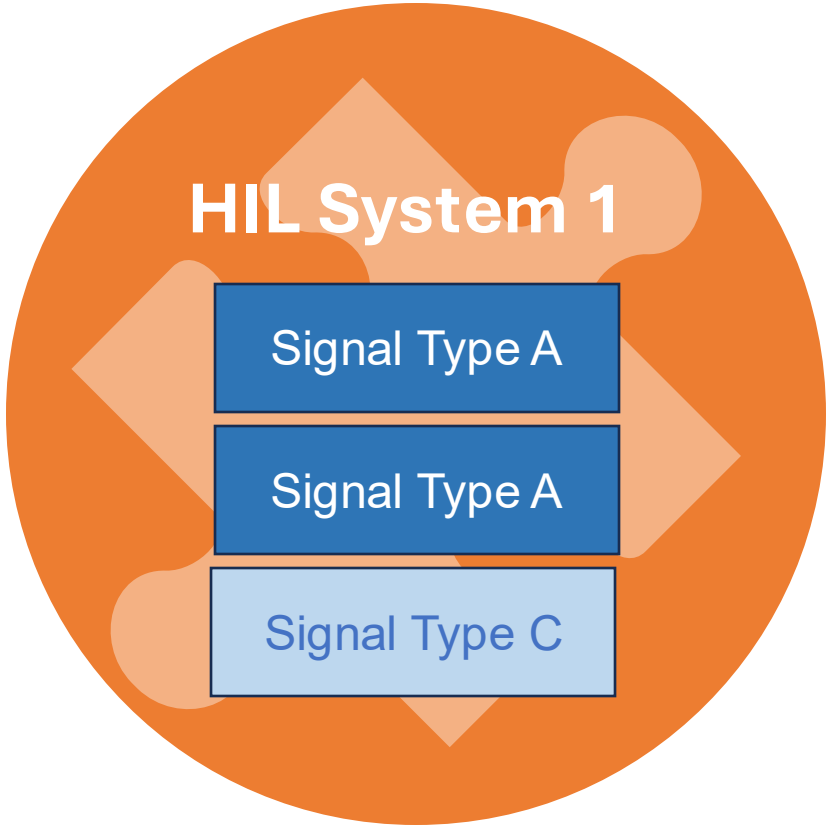
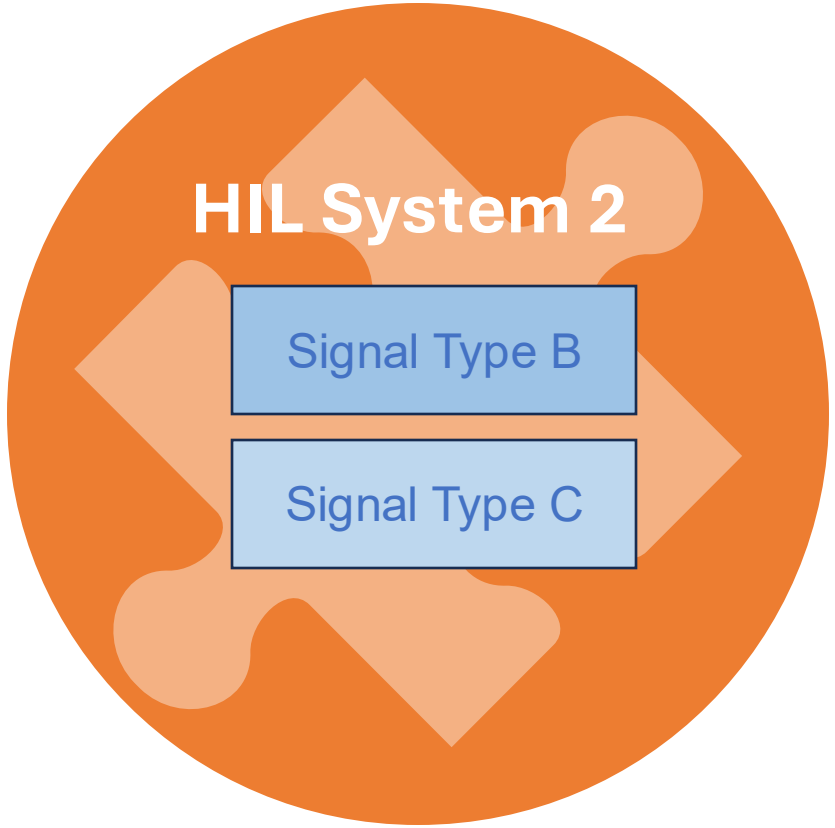
Subsystem Diagram: Generate Signal Types

Common Test Equipment and Standard Interfaces





Recompose signal modules into HIL systems

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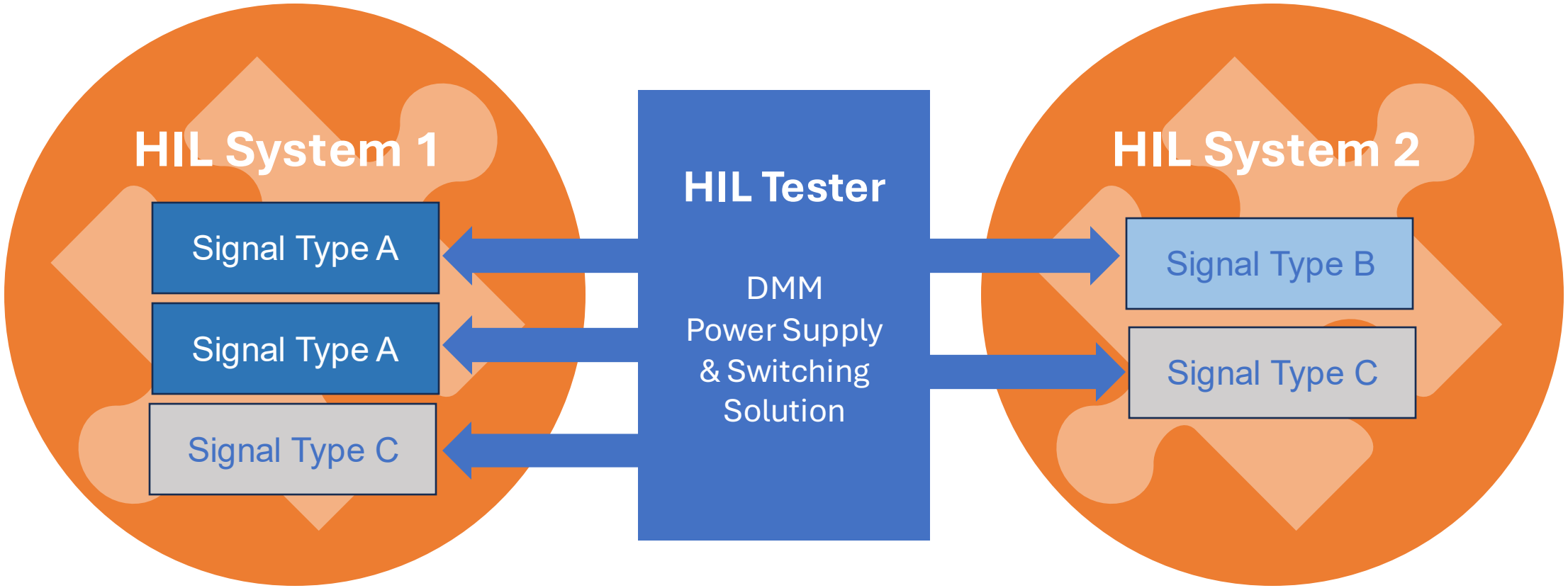
Subsystem Diagram: Generate Signal Types

Common Test Equipment and Standard Interfaces



Certify the HIL is working properly before connecting to units under test (UUTs)

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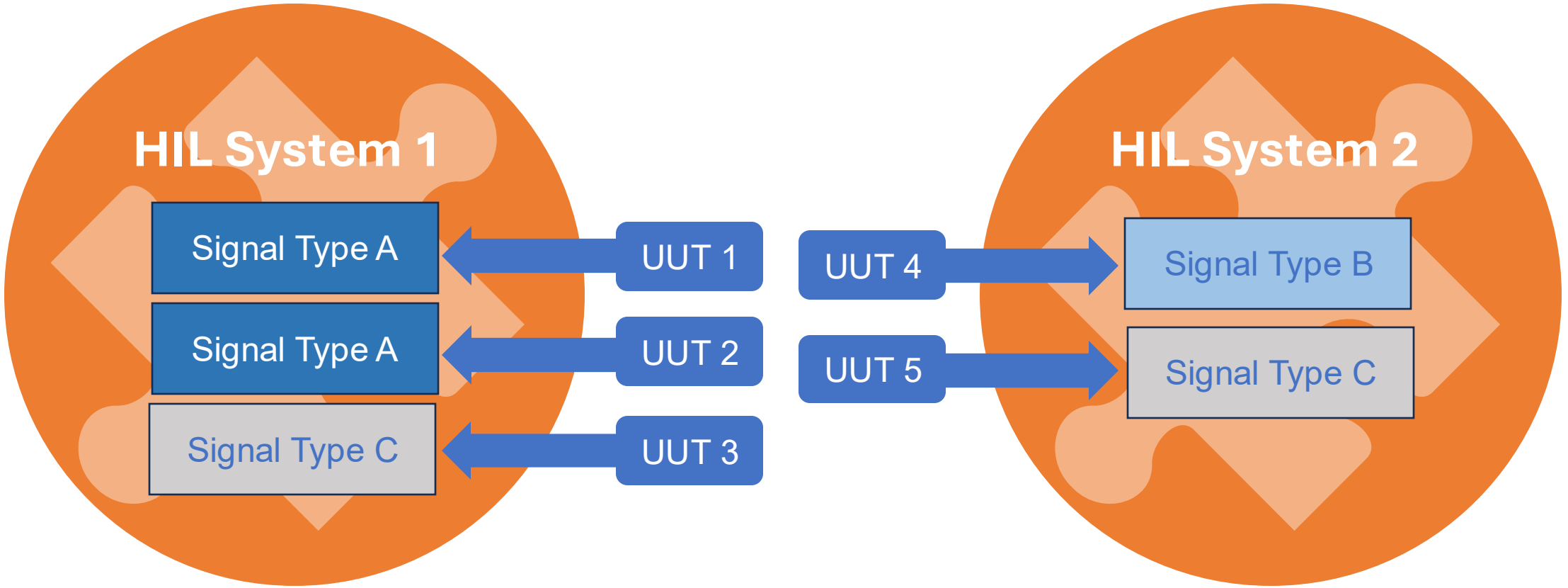
Subsystem Diagram: Generate Signal Types

Common Test Equipment and Standard Interfaces



Certify the HIL is working properly before connecting to units under test (UUTs)

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HIL Simulation & Modular Systems

Step 3: Select Your Test Equipment

Power Supplies

DMMs Digital Multimeters

Draw Up Your Test Cases

Merge Test Cases

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HIL Simulation & Modular Systems

Step 4: Switching Systems & Interfaces

Switching Systems

Interfaces

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HIL Simulation & Modular Systems

Step 5: Develop Your HIL Software Framework

- Adaptable to a wide range of needs
- Accurate logic for nominal and fault conditions
- User-friendly interface for control of HIL & components

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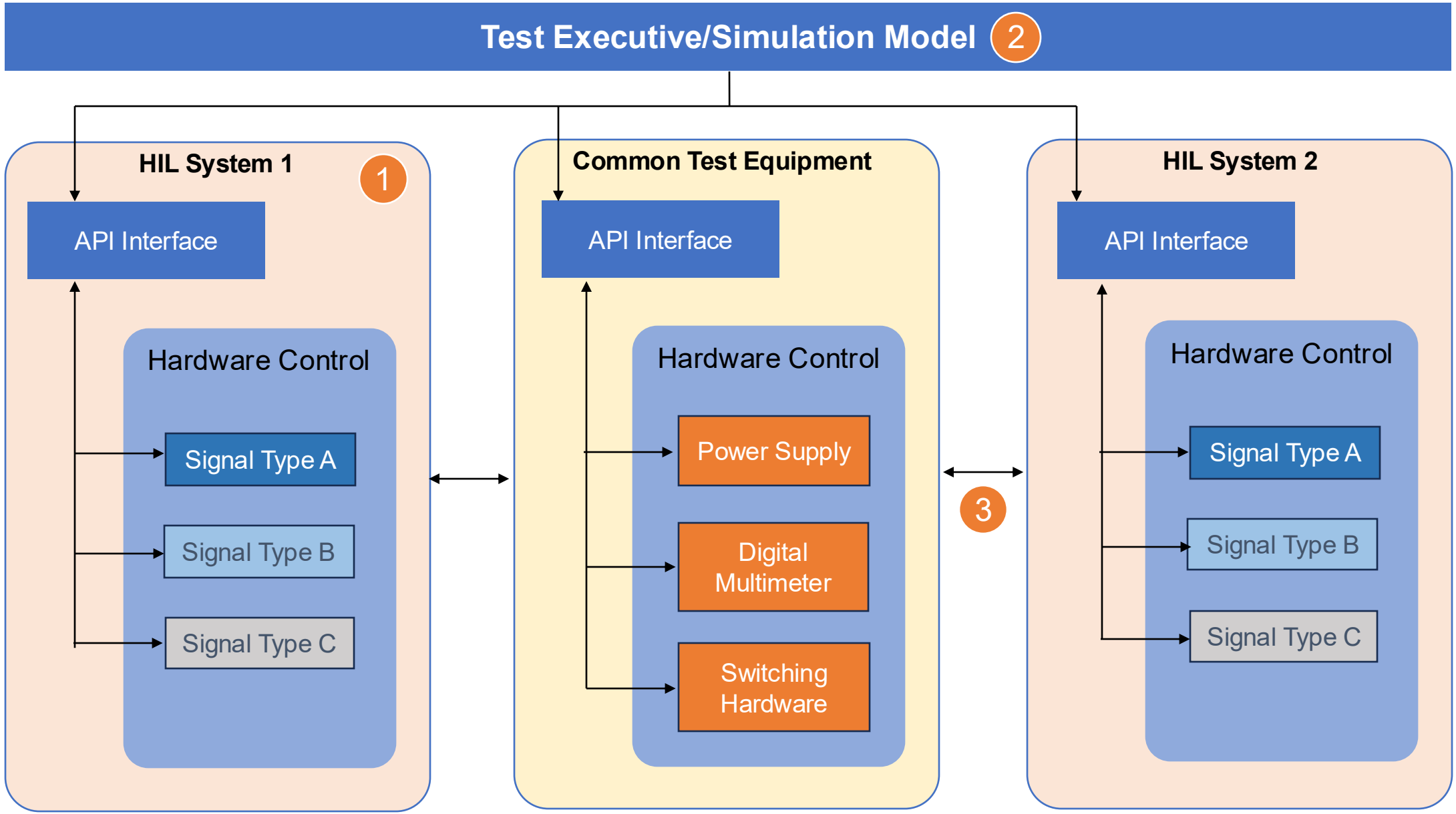
Software Architecture



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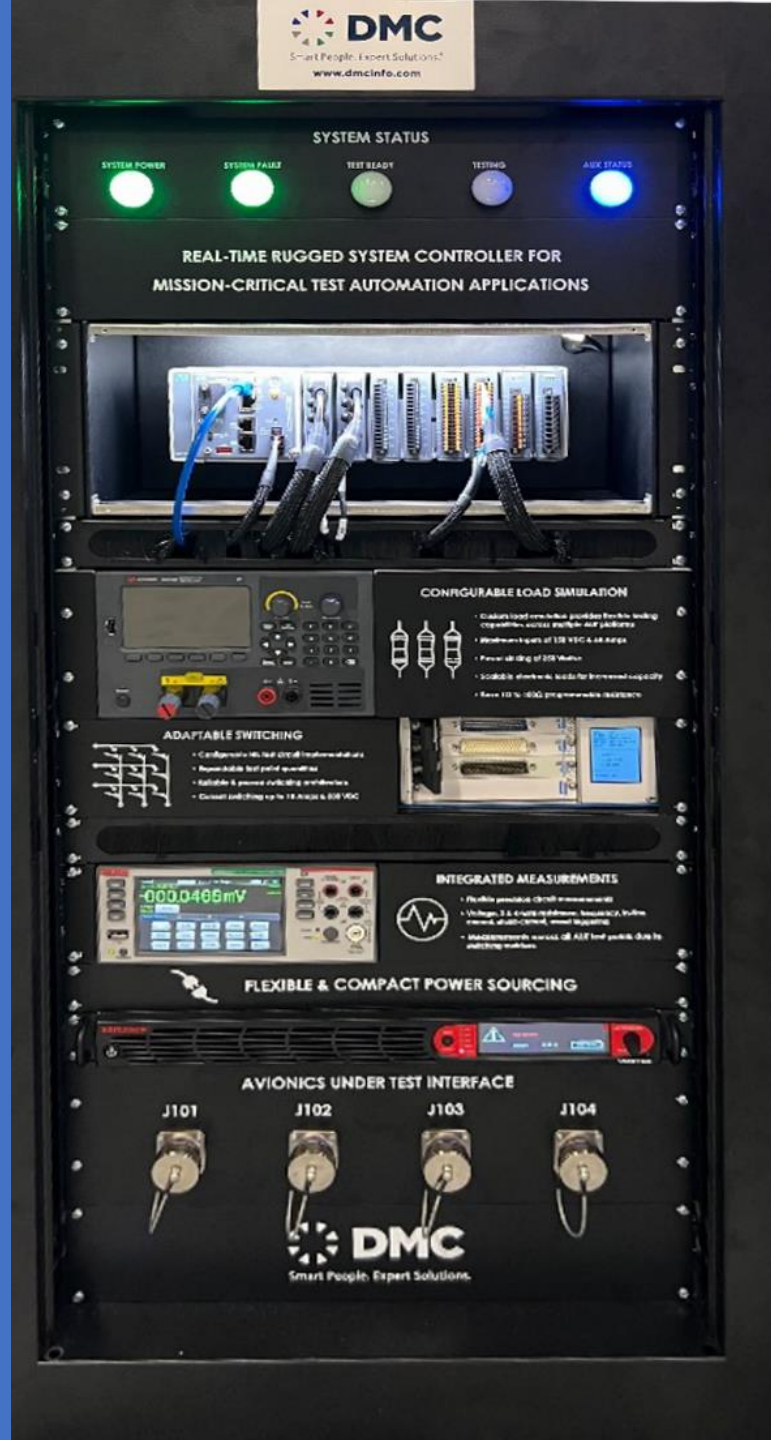
Helix SwitchCore – Configurable HIL Platform

A Configurable & Adaptable high-density multiplexing test system for System Verification/Validation and/or HIL verification

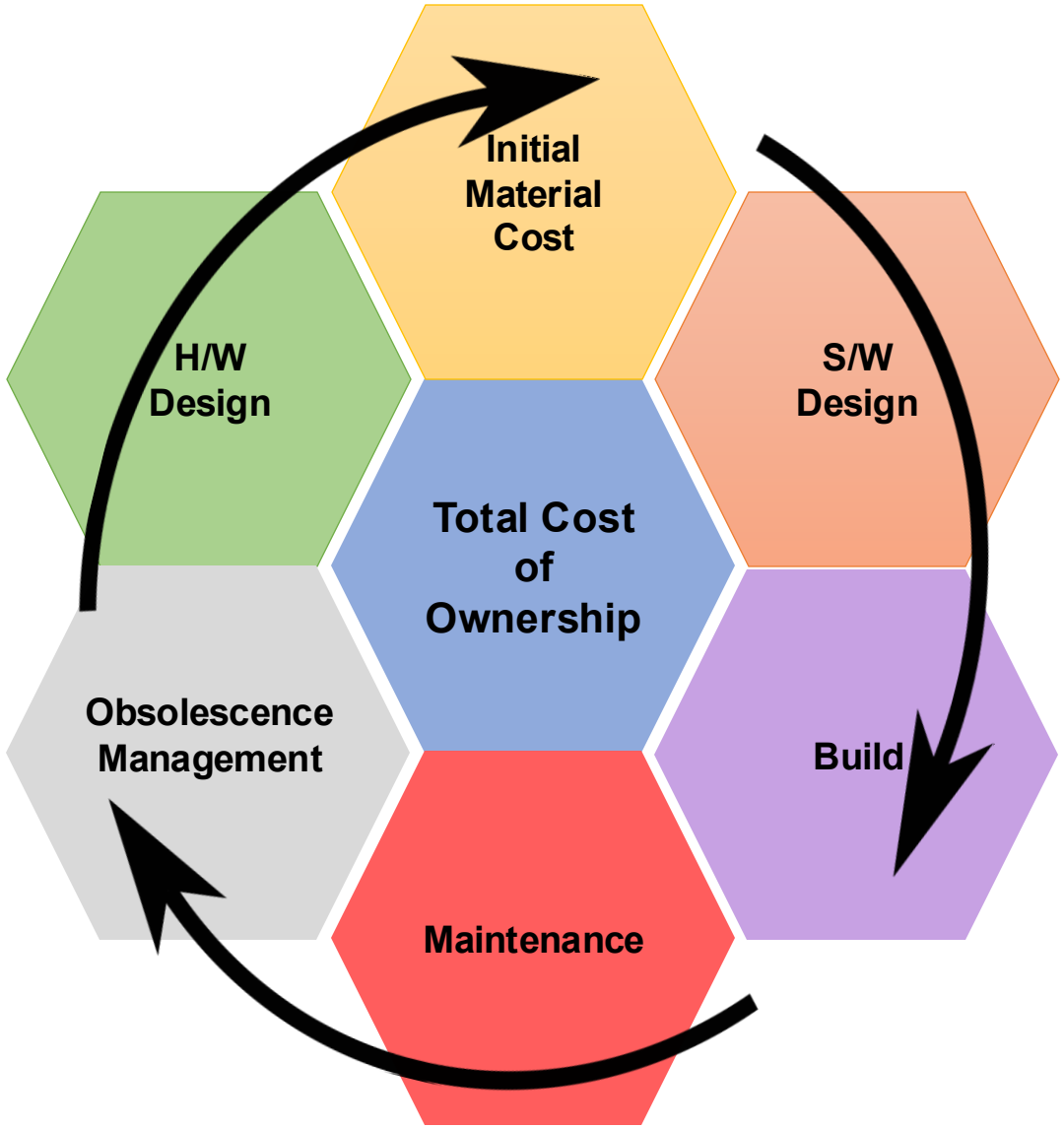
Key System Features

- Hardware Agnostic
- Non-Proprietary Software
- Low-Cost, High Impact
- Multi-Use
- High Stability Controller
- Compact “Lite” HIL



Common Challenges for Test Engineering Teams

- **Limited Resources**
- **Compressed Schedule**
- **Evolving Test Requirements**



The question is…

How do we employ an efficient development process that lowers the total cost of ownership?

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Flexible Platform Architecture

H/W Design

Proprietary modular form factors

2,000+ PXI/PXIe modules

LXI USB

PXI

PXI Express

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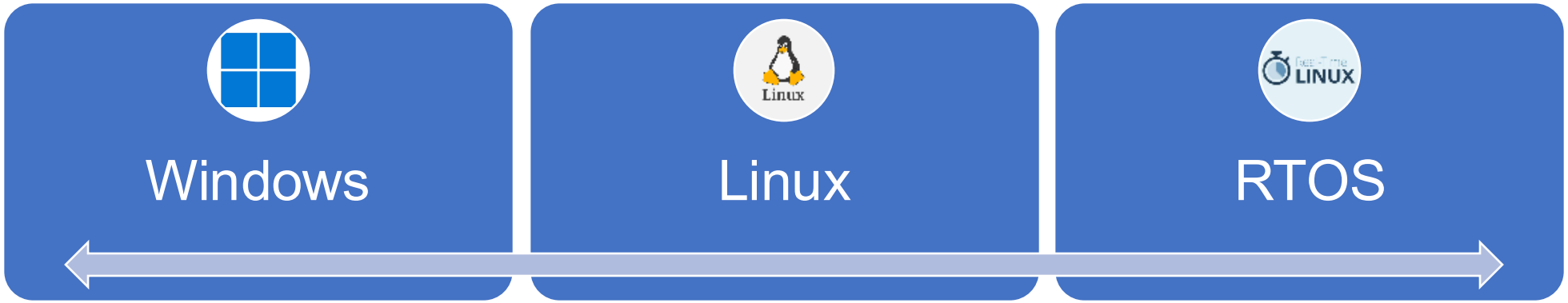
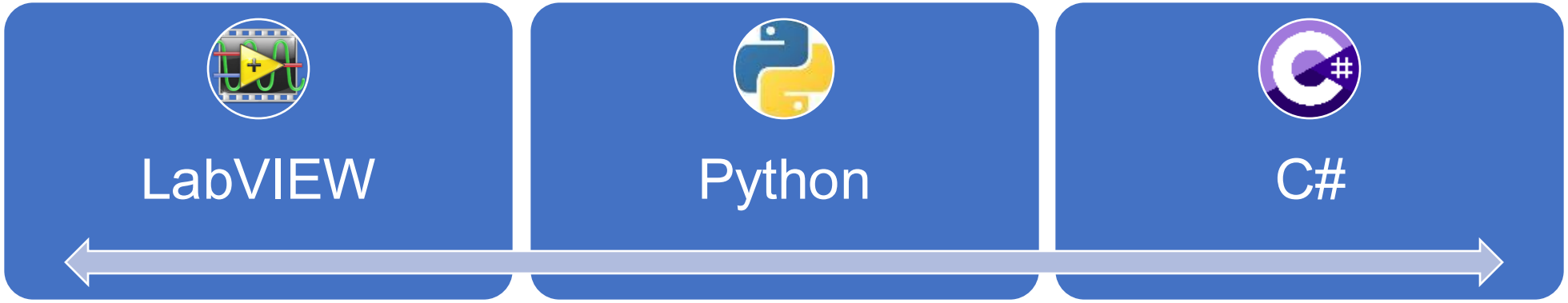
Software Flexibility

S/W Design

Operating System



Programming Language



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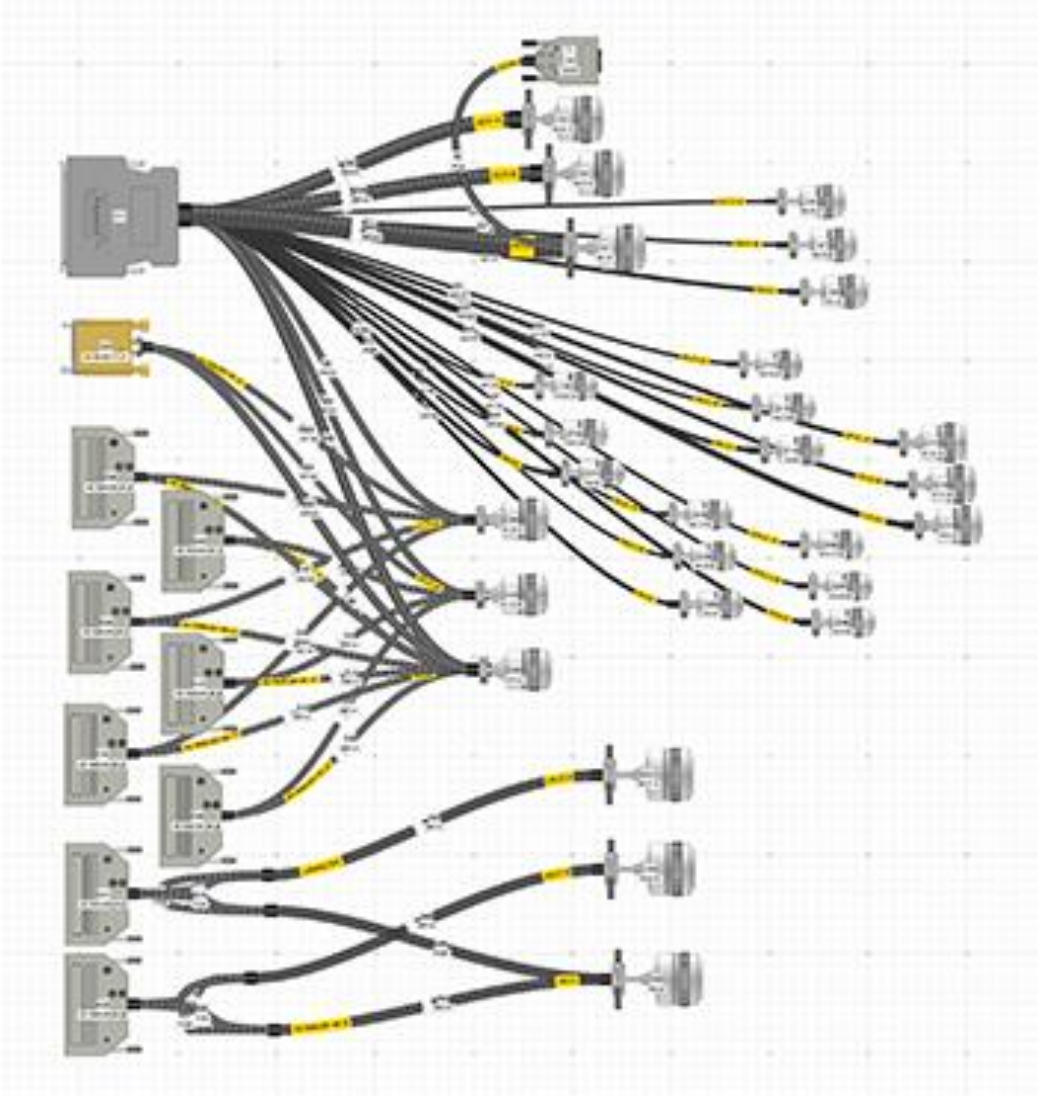
Expediting Cable Design/Build



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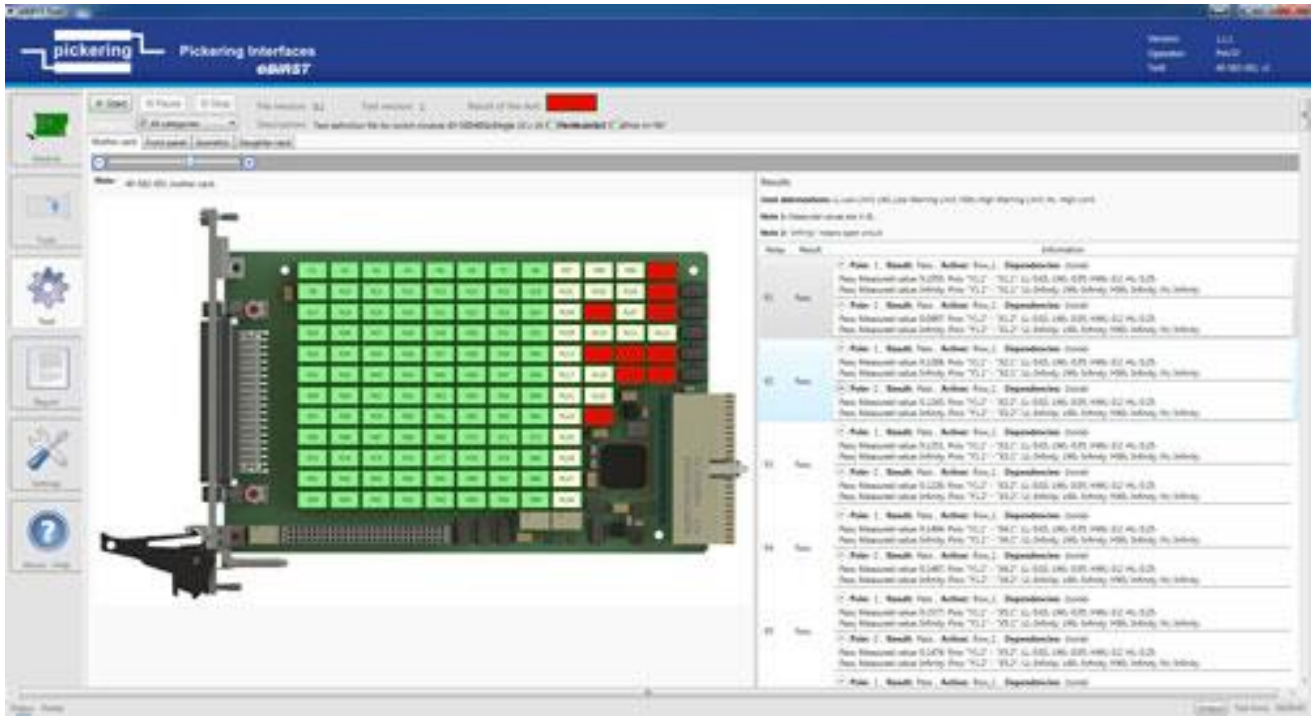
Maintaining Switching Systems: eBIRST

Maintenance



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Obsolescence Management

Obsolescence Management

- 3-Pronged Approach to **Obsolescence Mitigation**
  - Planning for obsolescence during the design phase
  - Using open-standard platforms
  - Designing out obsolescence whenever possible

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Design with Ease

- Expert support resources and cloud-based tools
- Deep product portfolio with >2000 PXI modules
- Rapid product customization and design services

Deploy with Speed

- Expansive IDE and OS coverage
- Productive application software
- Custom cable design and manufacture

Sustain with Confidence

- Highest quality relays
- Standard 3-year warranty with onboard spares
- 20+ year product lifecycles with free technical support

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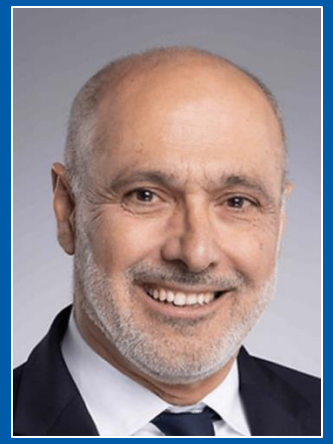
DMC/Pickering Collaboration

How we collaborate

- Present end-user with a single point-of-contact for the integrated HILS.
- Consult directly on planned uses of Pickering products.
- Get feedback or find alternate/better ways to structure things.
- Leverage use of open-platforms to maximize use of core competencies from multiple vendors.
- Provides Pickering with end-user feedback that helps drive product roadmap.

Q&A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